Location Based Services Enterprise Implementation Project Proposal

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Executive Summary

Location based services (LBS) are a subset of geographic information systems (GIS) technology supporting the integration of spatial location into business processes. The substantial majority of data resources maintained in state government contain some reference to spatial location. This can be in the form of a street address, zip code, city or county name, or an explicit map coordinate reference.

Integrating spatial location to business data enables advanced analysis that is not possible through traditional programming or database techniques alone. This locational component provides a means of relating disparate business data sets where there is not a conventional relational component in the database design(s). Each business data set can be related to the digital map; the digital map becomes the means for relating, comparing, and analyzing relationships in the data.

This proposal makes the case for implementing LBS as an enterprise service managed by the Division of GIS Services in the Office for Information Resources. Offering LBS as an enterprise service will most benefit agencies without existing resources dedicated to GIS support and development. The service will also provide an economical alternative to agencies with existing internal GIS resources, and will promote consistency in LBS development across state government applications.

The proposal provides a brief overview of LBS functionality, identifies technical issues to be addressed during the project, documents implementation strategies considered and components for establishing implementation costs, operational costs, and developing service rates. The proposal concludes with a list of recommendations and project timeline for implementing LBS in the state's production environment.

DRAFT

Location Based Services Overview

Location Based Services Defined

Location based services (LBS) encompasses a range of technologies with the common goal of utilizing location to enable or enhance a business process. The ability to determine location in relation to existing business data and information provides a significant opportunity for improving business processes and increasing analytical capabilities.

Information relating to location can be found in many datasets maintained by state and local government. Datasets containing locational attributes can be related in a similar way tables in a database can be related. The ability to join datasets by location provides a beneficial suite of options for analyzing datasets that do not have an inherent relationship built into the database design. The functionality to support LBS capabilities is a subset of geographic information system (GIS).

Scope of Location Based Services

Supporting location-based services requires addressing a number of factors including hardware, software, network infrastructure, database design, application development environment, and security. The implementation of these GIS/LBS technologies is based on mature and scalable multi-tier client-server technologies.

The development of LBS will represent the first step in implementing the Spatial Data Architecture (SDA). The SDA is the State of Tennessee's conceptual framework for the development of enterprise GIS. The technologies and experiences gained from implementing the LBS infrastructure will contribute towards the pending implementation of larger SDA components. LBS components will become part of the SDA, and as the SDA develops, this will offer increasing scalability and flexibility to existing LBS options.

For more information about the *Spatial Data Architecture*, visit http://gis.state.tn.us/sda.html

The range of consideration for LBS in the context of this paper will address the infrastructure and architecture requirements to support the suite of generic LBS services to support thin client applications and desktop services. The scope will not include addressing the use of mobile client applications. There are two important reasons for this. First, the majority of mobile client applications for GIS are driven by interaction with desktop clients. The primary interaction in this model is between the desktop client and the server hosting the LBS service. The mobile application clients in this model rely on "synchronizing" data and loading applications by communicating with the GIS desktop client. Second, there is not currently sufficient interest expressed from the GIS community to extend LBS to mobile client applications with wireless communication capability. It is noted, however, the basic infrastructure to support LBS applications can be extended to accommodate mobile client applications with wireless communication when there is sufficient interest to warrant this support.

Functional Description of LBS Technologies.

Geographic information systems (GIS) are used to maintain spatial data. Spatial data is any dataset that includes a reference to location. The references contained in spatial data can be explicit or implicit. An example of an explicit reference would be a latitude and longitude coordinate pair defining a point on the ground, while an implicit reference could be a street address or a zip code reference.

Within the scope of LBS technologies, there are a core group of functions that make LBS possible. The first premise of enabling LBS is ascertaining a locational attribute within a dataset. By definition, a dataset with an explicit spatial reference already contains this locational attribute. For datasets with an implicit spatial reference, the explicit locational attribute needs to be established. This is known as *geocoding*.

An example of geocoding would be analyzing a street address to generate a locational coordinate. Reverse geocoding would be analyzing a point to return a street address or zip code.

Geocoding can be accomplished in one of two ways. The first method uses a traditional database join or relate method to relate the dataset with an implicit spatial reference from an existing spatial dataset in the GIS, thus providing the explicit location. The second method involves the GIS resolving the implicit spatial reference into an explicit location and appending this information to the existing dataset.

There are some instances where a dataset already contains an explicit spatial reference, and the business case requires an implicit reference to facilitate reporting, analysis, or comparison to another dataset. This is an illustration of *reverse geocoding*. The explicit spatial reference is analyzed by the GIS, and the implicit reference is returned.

Another important LBS concept is *routing*. Routing is using the analytical capabilities of the GIS to provide detailed navigating directions between two locations. GIS functionality can be utilized to perform advanced analysis in the generation of directions. Examples of these types of capabilities would include the consideration of multiple interim points along the route, considering routes based on speed, time of day, construction, or current traffic conditions.

Implementing Location Based Services

The case for supporting location based services across agencies is significant and growing. This need is seen both in agencies with established GIS capabilities and agencies that have expressed the need for LBS to support existing or developing business requirements. This document makes the case for the support and development of an enterprise resource as an alternative to encouraging the development of multiple “stovepipe” implementations.

OIR-GIS Services has implemented a test bed for developing a base line in managing and maintaining LBS components. This test bed environment has been used successfully to work with agencies to evaluate the application development requirements and to confirm the value of LBS to existing and developing business requirements. These activities support the notion it is viable to develop a generic suite of LBS capabilities that can be utilized as an enterprise resource and service.

It is envisioned this LBS environment can be ready for production applications in a five- to seven-month time frame. This timeframe includes all required planning and development, acquisition, and testing.

Development and Research Issues

Through the implementation and activities as part of the LBS test bed environment several issues have been identified for consideration. Although the technologies for GIS and LBS are scalable, careful consideration must be given to a number of factors affecting the initial implementation.

Estimating Application Development Requirements

The application development environment touches on all of the physical infrastructure resources, policy implications and scalability issues. Utilizing products from Environmental Systems Research Institute (ESRI), the state standard vendor for GIS software, the primary software product is Arc Internet Map Server (ArcIMS). ArcIMS is a COM-based software library utilizing XML-based transactions to communicate with web servers and client applications.

Client applications can be either web clients or desktop clients. Desktop clients access ArcIMS services through a TCP/IP based connection. Web clients are developed in an application development environment appropriate for COM-based libraries. ArcIMS has options for using JAVA, ASP, or other similar application development and maintenance environments. In the test bed environment, an ASP client is used. The software vendor strongly recommends using ASP.NET given its focused support for interactive application development in a web environment.

The LBS test bed project has developed a generic LBS web client application based in ASP. This generic application structure has been modified to develop two proof of concept applications using data from the Department of Revenue, and the Department of Human Services, respectively. In both cases, modifications were made to the interface and business data to enable or enhance existing business processes using locational information.

Estimating Capacity Requirements

There is a range of factors to consider in developing an ArcIMS implementation in a production environment. The foremost consideration is the projected number of application requests that will need to be handled during a given period of time. This capacity requirement is generally expressed in peak transactions per hour. Once a target transaction rate is developed, the software vendor provides support for customers to project the hardware requirements to meet this goal, including recommendations for server processors (based on SPEC benchmarks) and memory requirements.

In developing server requirements for ArcIMS, the development of a peak transaction target will necessarily be a projection based on known requirements for pending applications already requested as well as a projection of requirements for applications to be developed in the future.

Customer Development and Management

The development of the LBS test bed environment has been a valuable benefit for OIR-GIS Services to evaluate the feasibility of developing generic LBS services for supporting the enterprise of state government. The exercise has also been useful for agencies that have participated in this evaluation process. During this process, the two proof-of-concept applications have been used to demonstrate the value of LBS to enable or enhance an existing business requirement on the part of the customers.

During this same time, a number of agencies have made inquiry to the application of LBS technology. This interest has been expressed in two general areas: web enabled applications based on LBS technologies, and bulk geocoding services. Web enabled application interest has been in the form of both providing GIS and spatial capabilities to internal staff (without requiring a full implementation of a GIS desktop client application) and to the public. Bulk geocoding services have been requested for a range of business and analytical capacities. In the case of both types of generic services, it is anticipated the awareness and need will grow once applications are developed in a production environment.

With the implementation of ArcIMS in a production environment, another benefit to the enterprise will be the opportunity to respond to the long-standing request from the state web community for custom map locator generation within the state web environment. Web sites developed by state agencies have historically relied on external links to public map generation websites (for example, MapQuest) for creating locator maps included on state web pages. The implementation of ArcIMS will enable the development of a standard resource for creating custom map locators available to the state web development community.

Location Based Services in the Spatial Data Architecture

The SDA provides for the implementation of enterprise GIS data and application development environment for State government. The impetus for the SDA is to make available the GIS data products produced by the Tennessee Base Mapping Program (TNBMP). These digital data products include orthoimagery, elevation data, parcels, centerlines, and hydrography.

The Spatial Data Architecture identifies the server components and associated infrastructure to support enterprise GIS. Primary server components identified include a geospatial warehouse, maintenance servers, and shared application servers. Servers established in support of generic LBS services represent shared application servers in the SDA environment.

The initial implementation of LBS server infrastructure will not rely on a geospatial warehouse. The pending development of the larger SDA infrastructure is forecast to begin implementation in a six- to twelve-month time frame after LBS services are ready for production mode. During this interim period, LBS services will be supported using data stored in a flat file format. The SDA geospatial warehouse will store data in a relational database management system (RDBMS). During this period, the performance level of the LBS server is projected to sufficiently maintain LBS services at an adequate service level. When the SDA geospatial warehouse is implemented, the LBS services will be migrated to utilize the geospatial warehouse as the primary data source.

Implementation Strategy

Implementation Models for Consideration

Within the state's information technology environment, there are numerous options open for consideration as viable implementation strategies. These would include outsourcing LBS services through a third party, encouraging agencies to develop independent LBS services internally, or offering LBS services as a generic enterprise service, similar to other OIR services such as database management, or application development.

In considering third party provision of LBS services, the primary factor of estimating capacities (peak and overall volume) ends up being a source of speculation. The potential for over- and underestimation necessitates some measure of inflation in competitive costing. The level of management for the initial procurement of services also represents a significant expense.

The ultimate conclusion is to recommend the development of enterprise LBS services offered as a service by OIR. This provides for the most economical solution for the enterprise and provides a tight integration with pending SDA development. Additionally, experiences gained from implementing LBS will provide valuable insight in the development of the much larger SDA servers.

Implementation Plan Development

The development and experience of the test bed LBS environment will be beneficial in the development of the LBS services implementation plan. Background in the setup and testing of LBS servers and software has been completed, and test applications already exist.

The LBS test bed experience will provide valuable guidance in areas to be addressed in the implementation plan that will need specific attention. Details in the production environment impacting LBS service implementation will include server security and network capacity requirements to be resolved with other sections of OIR.

Costs

Implementation Costs

The three primary costs of any information technology address startup hardware, required software, and personnel costs incurred to take a project from planning through production testing. The development of hardware server costs will be tied to the peak and daily server loads required to support LBS applications. Server scoping will also be adjusted to support the utilization of local flat files during the interim period for supporting LBS services, but before the SDA is available in the production environment. This means there will be a significant amount of excess capacity built into the server that will eventually be migrated to become a significant component of the SDA.

Software costs will be a function of the server hardware as the pricing for the ArcIMS software licensing is based on a per-processor basis. The ArcIMS software is part of the ESRI Master Purchase Agreement (MPA). Operating system software for the server will require the current Windows server software and the Internet Information Server web server, or similar comparable product.

Personnel costs will be addressed in the project proposal and cost benefit analysis. Costs will include the percentage of time OIR-GIS Services staff will be dedicated to the implementation phase of the project, required training identified during project development, and any development support provided by the software vendor.

Operational Costs

Operational costs for maintaining LBS services will be in line with standard information technology applications and practices. Server co-location fees, annual maintenance for hardware and software, disaster recovery planning, and standard system maintenance will be identified in the project cost benefit analysis. The project proposal and cost-benefit analysis will independently track these operational costs in the development of the initial project documentation.

It is noted at some time during the first two years of the operational phase of LBS, it will be more pragmatic to phase project management for LBS services into the project reporting and cost benefit accounting required for the larger SDA implementation.

Cost Recovery Model Components

Identified within the delivery of generic LBS services are several service areas that will offset costs and expenses associated with maintaining the enterprise resource: application development, application maintenance, ad hoc geocoding, and application hosting.

Application Development

This service will encompass assisting agencies in the development of LBS applications. This will include all phases of project proposal development, assistance in developing appropriate spatially enabled business logic and application requirements, development of data sets, application development, testing, deployment, and training development.

Application and Data Maintenance

This service will address periodic maintenance of LBS applications and data. This category enables OIR-GIS Services and agency customers to address periodic updates of spatial data sets, and translation of data generated by the LBS application. This type of process will be automated whenever practical.

Ad Hoc Geocoding

The Ad Hoc Geocoding service will entail assisting agency customers to batch geocode very large datasets. This service will have the most value and potential for agencies without an existing in-house GIS capability. Currently, batch geocoding is an interactive process. As part of LBS service development, the loading and generation of spatially-enabled output datasets will become an automated process.

For batch geocoding, data integrity is paramount to good results. In practice, it will be rare for existing data sets to have good data integrity built into the implicit spatial references such as address and zip code fields. In these cases, the pretext of using the data resource as an input to geocoding was never a consideration in the initial database development. This will result in an iterative approach to assist agencies in identify records for evaluation and correction.

Application Hosting

For agencies with developed in-house GIS capabilities, services hosted and maintained will provide an economical alternative to developing an LBS services infrastructure within an agency. Considering the implementation costs of hardware, software, and personnel, an enterprise level resource will support access to LBS, all but the largest agencies will be hard pressed to justify development of a comprehensive suite of LBS services.

Benefits

Benefits to the Enterprise

The development of enterprise-level LBS services is well founded in information technology principles. The development of enterprise LBS services will provide the opportunity to spatially enable existing applications. Development of a community resource encourages and supports the concept of a common base map across the enterprise of state government. Successful deployment of enterprise LBS will also raise the level of GIS awareness across all levels of state government management. Finally, the process of developing the enterprise LBS environment will provide an important foundational component for the pending implementation of the Spatial Data Architecture.

Benefits to Agencies

As with any information technology, the primary benefit of a shared service is the opportunity to reduce duplicative services while simultaneously gaining access to a higher quality service than any one agency could provide singularly. Enterprise LBS services will have the most impact for agencies recognizing a need for LBS, but lack a dedicated in-house GIS capability. Participation in an enterprise LBS service can also facilitate the potential for cross agency or even multi-agency application development, using access to the common mapping resource for relating disparate datasets.

Recommendations

This section lays out the steps for developing LBS services into an enterprise resource. Through the development of the LBS test bed and this document the following recommendations and commitments are required to move forward with this project:

- Hardware, software, and infrastructure costs for implementation are estimated at $55,000. This includes application server hardware, operating system software, application software, backup equipment, and services from F&A-ISM and OIR to install the system at the Data Center.
- Personnel requirements are projected to be one FTE for six months to manage implementation planning, cost modeling, and implementation and testing over and above current staffing levels for OIR-GIS Services. In the absence of additional staffing, the timeline for implementation will increase to a twelve to fifteen month estimate.
- Training costs are dependent on the qualifications and ability to attract a suitably trained candidate. It is reasonable to anticipate attracting a suitably trained candidate, however it is noted there may be some need for training and/or acquisition of professional services if necessary. If additional staffing is not acquired, training and/or acquisition of professional services will become an additional requirement.
- Operational costs are projected to be $22,000 for Data Center co-location costs, hardware annual maintenance, and software annual maintenance.
- LBS-dedicated hardware and software will become integral parts of the Spatial Data Infrastructure. Implementation of the hardware and software components of the SDA will occur in mid-2006, as such, the LBS hardware and software will be integrated with the SDA for project management purposes. Hardware replacement will be considered in the scope of SDA management.

Implementation Plan

Development of an LBS enterprise services implementation plan is the next step in the process. Appropriate sections of OIR will be interfaced with the implementation plan development to address specifications of the hardware and software, facilities requirements with the State Data Center, the application development environment, security, and disaster recovery. This section will also address the development of the project proposal and cost benefit analysis documentation for the IT-ABC process. This section will take a maximum of three months upon commencement.

The application server speced will be capable of 10,000 peak transactions per hour based on flat file data stored on the application server. This capacity is deemed sufficient to support LBS requirements through mid-2006. With the development of SDA components in mid-2006, in particular the geospatial warehouse (database server) component, LBS services will be converted to utilize data served from the geospatial warehouse. This will increase the capability of LBS to serve 20,000 peak transactions per hour with minimal adjustments in the hosted services and minimal to re-write existing application coding.

Cost Model Development

Concurrent with the development of the implementation plan will be the development of the cost model for supporting enterprise LBS services. The development of the CBA will capture implementation and operational costs that need to be recaptured as services to agencies. This information will be used to develop a rate structure in coordination with OIR-Financial Management based on services and components identified previously in this document. This section will be closely tied to the timeline for the Implementation Planning section, but may remain independent as appropriate.

Implementation and Testing

With the successful conclusion of the Implementation Planning phase, the next phase will include the acquisition, installation and testing of system components. Many of these issues have been addressed in the development of the LBS test bed, although it is acknowledged this will be OIR-GIS Service's first opportunity for implementing a system in the Data Center environment.

This phase will be assisted in the existence of proof-of-concept applications developed as part of the LBS test bed, which will provide representative data and applications for verification of performance metrics during this step.

Implementation and testing will is projected to take a maximum of four months to complete after commencement.

Production Status

The enterprise LBS service will be ready for the production environment no later than seven months on commencement of implementation planning, or sooner depending on the prioritization of project requirements.

Glossary

application server – A component of the geospatial data architecture dedicated to running applications services using data from a geospatial warehouse.

application service – A service run from an application server designed to utilize data from a geospatial warehouse. An example of an application service would be a web-mapping service.

ArcIMS – (Arc-Internet Mapping Service) A commercial application provided by ESRI for developing applications services. The most popular service is a web-application service. ArcIMS simultaneously builds and manages the user interface and the analytical and display functionality of the web mapping application.

ArcInfo – A commercial GIS application from ESRI. ArcInfo is marketed towards professional users.

ArcPad – A commercial GIS application from ESRI. ArcPad is thin-client application for PocketPC-class machines. It is optimized for use in wireless application development.

ArcView – A commercial GIS application from ESRI. ArcView is marketed towards application users.

attribute component – The component of spatial data involving the measurement and storage of attributes about a spatial data feature.

Content Standard for Digital Geospatial Metadata (CSDGM) – The current metadata standard for documenting geospatial data.

custodian – Agency or agencies that accept responsibility for coordinating maintenance for a geospatial dataset involved with the SDA.

Environmental Systems Research Institute (ESRI) – Commercial vendor of GIS software selected as State standard by ISC in 1992.

geodatabase – The data model used by ESRI for representing geospatial data in an object-relational data structure.

geographic information system (GIS) – A digital system designed for the creation, management, analysis, and display of geospatial information.

geospatial application – An application designed to operate on geospatial information.

geospatial data – A digital representation of a real world feature with attributes describing characteristics of the feature and its location.

geospatial data infrastructure – The hardware, software, and personnel required to implement the vision of the SDA.

location based service – An application or output from an application that utilizes location to enable or enhance a business process.

maintenance server -- A component of the geospatial data architecture dedicated to running applications services for maintaining the data in the geospatial warehouse.

maintenance service -- A service run from an application server designed to serve or maintain data from a geospatial warehouse. An example of a maintenance service would be an application for loading updates of data to the geospatial warehouse.

metadata – A formatted record using CSDGM for describing characteristics about a geospatial dataset.

Spatial Database Engine (SDE) -- A commercial application from ESRI designed to support the processing of geospatial data using commercial database products.

spatial component – The component of spatial data storing the geometric representation of a spatial data feature, or a reference to a geometric representation, or a reference to a real-world location.

spatial data architecture (SDA) – The enterprise vision for coordinated implementation of geospatial data across government in Tennessee.

Tennessee Base Mapping Program (BMP) – Five year program to produce essential geospatial data for analytical and cartographic products and services in cooperation with local governments.